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Protein content classification of foods: Should North America follow Europe to prevent the risk of chronic disease and protect the environment?

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Abstract

Dietary advice to the public encourages consumption of plant-based diets in order to increase the population's intake of plant proteins while reducing their use of animal proteins. This change is challenging, especially in North America where the public lacks guidance on how to identify protein-rich plant-based products. This challenge arises from a regulatory issue. In Canada and the United States, the Protein Efficiency Ratio (PER) and Protein Digestibility Corrected Amino Acid Score (PDCAAS) methods of assessing protein quality are used to determine whether a protein content claim can be made. However, both of these methods favour animal protein sources. The original rationale behind these claims was that animal sources of protein are better for the growth of children (in the case of Canada, young rodents), as opposed to plant-based proteins. However, "bigger" may not be "better" and evidence suggests that components of animal foods, such as red meat and processed meat may indeed be harmful to health, particularly cardiovascular disease, due to the saturated fat and cholesterol content and their ability to act as substrate for trimethylamine N-oxide (TMAO) synthesis. Health reasons, including reduced cardiovascular disease (CVD) and increased longevity, together with environmental reasons, strongly suggest that the classic view of protein quality may not be relevant to long-term health, when proteins of differing amino acid contents are "mixed" (complementary), thus deficiencies in specific amino acids are unlikely. Further, specific amino acid deficiencies are not a feature of those consuming proteins from plant-based sources while taking an otherwise adequate diet. Removal of protein quality would allow good plant protein food sources to be declared as such on the front of pack labelling to alert the consumer to plant protein foods.

Introduction

Legislation, especially in North America, that inhibits front-of-pack nutrition claims for plant protein, is at odds with the general dietary advice given internationally that recommends eating more plant-based food sources [1–9]. This legislatory impediment is based on a number of historical health concerns. The primary concern is that plant-protein foods are low in essential amino acids [10] and have reduced digestibility, which would therefore not adequately support growth and tissue repair, processes which are especially important for children and young adults. Canada applies the oldest system of protein assessment, the Protein Efficiency Ratio (PER) classification of proteins. PER compares the ability of a protein source to maximize the growth of young rodents relative to that of casein (milk protein) [11,12]. This method takes deficiencies in the amino acid profile and digestibility into account. The United States uses the Protein Digestibility Corrected Amino Acid Score (PDCAAS) model [8]. Relative to the indispensable amino acid requirements of a reference population (2-5-year-old children), it combines the chemically determined amino acid profile with the digestibility of the protein source, which is tested by fecal nitrogen levels in rodents or in humans (more expensive) [8,11,13]. In

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both Canada and the US, depending on the protein rating or corrected protein relative to a 50 g daily value for protein, "good source" and "excellent source" of protein claims are permitted, respectively. Again, both models favour animal protein to promote the goal of maximum growth and assume that the indispensable amino acids from foods that do not meet a threshold for protein quality are not of value in the context of healthy dietary patterns. Conversely, Europeans have dispensed with the concept of "protein quality" for front-of-pack protein claims.

Relative to total protein intake, current consumption rates of plant and animal-based protein differ across jurisdictions. In the US, data from the National Health and Nutrition Examination Survey (NHANES) 2007-2010 demonstrated that total protein consumption was approximately 62% from animal sources (animal + dairy) and 30% from plant-based sources [14]. The remaining 8% was unclassified. In Europe, results from the European Prospective Investigation into Cancer and Nutrition (EPIC 1995-2000) showed that, depending on the country, 23-73% protein was from animal-based foods, 24-70% protein was from plant-based foods, and 2-9% from unknown sources [15]. Individuals classified as "health conscious" in the UK consumed the highest proportions of plant-based protein at 70% [15]. It is acknowledged that for some jurisdictions in Europe, the relative levels of plant- and animal-based proteins are similar to what was observed in the US. However, given that regulations in Europe permit more plant-based foods to be claimed to be a source of protein, consumers will be given the tools to choose these foods more often as they are increasingly emphasized as a means of prioritizing health and decreasing the effects of diet on climate change.

The European Approach

Thus, in Europe, a food qualifies as a "source" or "high source" of protein if the food contains respectively ≥ 12% or ≥ 20% energy from protein [16]. In conjunction with this approach the Dutch have suggested limiting meat meals to 2 per week, the Belgians have suggested that plant foods should from the basis of all meals and the British advise the increased use of legumes and nuts and reduced meat intake as part of a healthy diet [1–7]. All these approaches will increase the intake of plant proteins and reduce animal protein intake since meat is the major animal protein source consumed in Europe as seen in the ARIC study that summarized the dietary intake of ten European countries, namely Denmark, France, Germany, Greece, Italy, Norway, Spain, Sweden, the Netherlands and the UK [17].

The reasons for not focusing on protein quality and animal foods

Selective amino acid deficiencies [18–20], including protein deficiency, are not an issue either in the general population of Europe or North America, except for in the frail elderly and in hospitalized patients [21]. Rather, excess calorie consumption and the aging population have become the significant drivers of chronic disease in western nations. These are major causes of suffering and are of economic concern as health care budgets rise exponentially [22]. Perhaps most importantly, and recently recognized, is concern regarding the role of human dietary patterns, especially the consumption of animal foods, on climate change and mass extinctions [23,24]. Previously it has been estimated that the background extinction rate was between 0.1 to 1.0 species lost per 10000 species per century. However recent estimates show an increase in this rate starting from 1500 AD and beginning to rise exponentially after 1800 AD. Looking only at mammals, the present rate may be as high as 2.5 species lost, compared to the 0.1-1.0 historical loss, representing a possible 25-fold or 2500% increase in mammalian species loss [25]. The mass of humans is an order of magnitude higher than that of all wild mammals combined [26]. With the exception of pollinators, that also face extinction [27], only insects appear to have prospered, specifically those phyla that carry human disease (e.g. ticks carrying Lyme disease [28], mosquitos carrying malaria [29] etc.), or beetles destroying forests, all of whose habitats have extended into northern latitudes.

Despite these reasons, the current emphasis in North America on protein quality is to ensure the primary status of animal foods (beef and dairy) in the diet, linked to their role in increasing growth potential [30,31].

The bigger, the better

"Little old ladies" is a colloquial phrase that links size and female sex with longevity. Some may say that being smaller in size is pathological resulting from vertebral collapse, but this does not account for the ubiquitousness of small size and longevity. This phenomenon was highlighted when comparing American presidents' longevity, who as a group have largely similar socioeconomic backgrounds. Here too, even excluding violent deaths (Abraham Lincoln was tall), there was no evidence that taller presidents have longer lifespans [32].

On the basis that more is better, there has been concern that non-dairy, plant-based milks should not be fed to children since they were associated with a shorter stature [33]. No distinction was made between soy and pea (legume) milks with the same protein content as dairy milks. With protein contents of 1-2g/250ml, almond, rice, and oat milks have lower protein levels than dairy milk (7g/250ml). However, the protein content of soy and pea milks range from 6-9g/250ml and yet are still considered inferior to dairy milk as protein sources. However, the superior health benefit of cow's milk has been challenged by data from the Nurses Health Study and the Health Professional study demonstrating that there was no association between high milk consumption during the peripubertal period and hip fractures in later life in women. While for man, in fact more hip fractures were seen with higher milk intake early in life [34]. The reason appeared to be longer femoral neck lengths. Thus, an unintended consequence favouring smaller size. Increased height has been associated with increased cancer risk, possibly due to higher growth hormone and other growth factor levels during the peripubertal period [35,36]. The Nurses Health Study data also indicated an association between high meat intake in the peripubertal years and the development of breast cancer later in life [37]. The degree to which a plant versus animal protein diet is of benefit once obesity is established is not so clear. Although plant-based diets benefit those with type 2 diabetes, the majority of when one overweight or obese. However, in general lower weight has been recorded for those consuming plant-based diets [38].

Thus, early vertical growth (height) may be associated with adverse health consequences later in life, similar to later life growth in the horizontal direction (obesity). The associations between being overweight and the development of diabetes, CVD, and cancer have been well documented [39–41]. In nutrition, more growth is not always optimal. This should be considered when choosing how to educate the public (through front-of-pack labelling) on beneficial protein sources, specifically plant proteins (peas, beans, lentils, and even leafy vegetables are good protein sources if eaten in significant quantities).

International increase in national recommendations promoting plant foods

Starting with Sweden in 2009, this decade has seen a major shift away from animal products in the diet, instead promoting the increased

use of plant-based foods and plant proteins both for health and environmental reasons [1]. In 2015, many countries started to introduce similar changes into their dietary guidelines. Holland recommended limiting servings of meat to twice per week [2], the United States went as far as including a vegetarian diet as one of their three recommended dietary patterns [3], China advocated cutting meat consumption by 50% [4], and the United Kingdom recommended eating more beans and pulses and less red and processed meat [5]. The British Eatwell Guide depicts a plate with a huge selection of fruit and vegetables (at least five portions daily), a large selection of starchy food (emphasizing wholegrain and high-fiber forms), and two small portions for meat, dairy, and their alternatives. It is worth noting that the plate does not contain any beef, mutton, or pork [5]. In 2017, Belgium recommended that plant foods should form the basis of all meals, with limited use of animal products [6]. In the same year, Canada outlined the suggested direction for the new Canada Food Guide that would be more plant-based, especially regarding proteins, citing both health and for the first-time environmental concerns [7]. Recent studies continue to indicate the advantage of plant proteins over animal proteins in terms of reduced all-cause mortality [42].

Health benefits of plant proteins

Large cohort studies and meta-analysis have indicated differences in health outcomes between animal and plant protein sources. Combining data from both the Nurses' Health study and the Health Professionals studies (n = 131,343) demonstrated in those with one lifestyle risk factor for CVD that although animal protein was not associated with all-cause mortality it was associated with increased CVD mortality. A beneficial pattern was seen with plant proteins where both lower all-cause mortality (HR = 0.90 per 3% energy increment, $p < .001$) and reduced CVD was seen (HR = 0.88 per 3% energy increment, $p = 0.007$) [43]. Substituting vegetable protein for processed meat, unprocessed red meat or eggs all significantly improved all-cause mortality.

Similar effects were seen in the Adventist study-2 cohort of men and women (n = 81, 337) where for CVD the HR was 1.61 for meat protein and 0.60 for nut and seed proteins ($p < 0.001$ for both) although other plant protein sources (including cereals and legumes) did not show a benefit in that study [44]. In this respect the PURE study is notable in showing an all-cause mortality reduction with pulse intake as another major source of plant proteins in a study that included jurisdictions with participants with lower socio-economic status [45].

In a meta-analysis of clinical trial participants, it was shown that replacing animal with plant protein improved glycaemic control [46]. Again, the Nurses and Health Professionals' Studies have shown that using plant proteins and oils to replace animal protein and fats in the diet was associated with reductions in both CVD and diabetes incidence [47,48]. Meta-analysis has also shown benefits from plant-based diets on blood pressure reduction [49] and on improved bone health [50].

Environmental considerations

Not only is animal agriculture a major source of greenhouse gas emissions (GHGEs), but total land use is also excessive. The cattle industry contributes as much as 14% to GHGEs, and there are additional concerns over antibiotic resistance, water use, and pollution of water with faecal effluent. If current U.S. department of agriculture (USDA) food guide recommendations were applied to the entire world population, agriculture would require an additional giga hectare, an area the size of Canada, to support it [51,52]. This dire prediction was made for the new US dietary guidelines despite the fact that they are more plant-based and therefore require considerably less land use than previous versions. Furthermore, global warming may have other concerning impacts on population health. For example, there was a direct relationship seen between ambient temperatures at the time of diagnosis and the increased incidence of gestational diabetes (GDM) in Canada. As a result, it has been suggested that as climate temperatures rise, there will be more cases of GDM. This is of importance as women with a history of GDM are at an increased risk of developing type 2 diabetes later in life [53].

"Where's the Beef?"

It may seem to the beef industry that there is an international conspiracy to destroy their industry, but the data on meat as a protein source demonstrate that meat is becoming increasingly unattractive for health and environmental reasons.

Recent studies have linked meat consumption with diabetes, CVD, and certain cancers, including colorectal cancer [54–58]. The components of meat thought to contribute to the pathogenesis of these diseases include saturated fat, cholesterol, and high levels of essential amino acids [59]. For example, arginine has been proposed as essential for growth in children, but essential amino acids may also increase serum cholesterol levels [59], and possibly CVD risk despite arginine's beneficial effect in stimulating nitrous oxide synthesis. Additionally, due to the association of animal proteins with growth in general, they may also enhance tumour growth [58]. Heme iron may act as a pro-oxidant, and pro-oxidants in turn have also been linked with CVD (hence the use of anti-oxidants in preventive strategies). Meat products are also rich in carnitine and choline, which can be converted by colonic bacteria to trimethylamine (TMA) that is absorbed and oxidized in the liver by flavine oxidases to form trimethylamine N-oxide (TMAO). TMAO is a NF-KB stimulator, which activates the inflammasome, leading to increased subintimal uptake of oxidized cholesterol and thus may contribute to arterial wall damage and increased CVD risk [60–63]. At the same time, TMAO appears to increase insulin resistance [60]. A toxic effect of TMAO on pancreatic β cells has not yet been demonstrated, however it has an effect in increasing fibrosis in renal and cardiac tissue [60]. High TMAO levels have been associated with increased CVD and reduced longevity [61,63-65].

The evidence against the consumption of red and processed meats, although largely by association, continues to build and further supports the need to identify and promote plant protein sources.

A weakness of our report is that although front of pack protein claims is allowed in Europe we know of no studies that demonstrate that they increase consumption of, for example, legumes or soy milk. Nor do we have data on the all-important link between these front of pack claims and health outcomes. Such data would be helpful in devising public health strategies to increase plant protein consumption.

Conclusion

For both health and environmental reasons, it is important to address the need in North America to promote consumption of higher plant-protein diets. From a public health perspective, it appears counterproductive that international and local dietary advice should not be supported by a regulatory definition that puts an emphasis on plant protein sources as valuable sources of protein.

In summary, plant sources should be able to make similar claims on front-of-pack labels as animal sources of proteins. Future front-of-pack labels could then make statements such as "A good source of plant protein, AS RECOMMENCDED IN DIETARY GUIDELINES"

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He has been on the speaker's panel, served on the scientific advisory board and/or received travel support and/or honoraria from the Almond Board of California, Canadian Agriculture Policy Institute, Loblaw Companies Ltd, the Griffin Hospital (for the development of the NuVal scoring system, the Coca-Cola Company, EPICURE, Danone, Diet Quality Photo Navigation (DQPN), Better Therapeutics (FareWell), Verywell, True Health Initiative, Institute of Food Technologists (IFT), Soy Nutrition Institute (SNI), Herbalife Nutrition Institute (HNI), Saskatchewan Pulse Growers, Sanitarium Company, Orafti, the Almond Board of California, the American Peanut Council, the International Tree Nut Council Nutrition Research and Education Foundation, the Peanut Institute, Herbalife International, Pacific Health Laboratories, Nutritional Fundamentals for Health (NFH), Barilla, Metagenics, Bayer Consumer Care, Unilever Canada and Netherlands, Solae, Kellogg, Quaker Oats, Procter & Gamble, the Coca-Cola Company, the Griffin Hospital, Abbott Laboratories, the Canola Council of Canada, Dean Foods, the California Strawberry Commission, Haine Celestial, PepsiCo, the Alpro Foundation, Pioneer Hi-Bred International, DuPont Nutrition and Health, Spherix Consulting and WhiteWave Foods, the Advanced Foods and Material Network, the Canola and Flax Councils of Canada, the Nutritional Fundamentals for Health, Agri-Culture and Agri-Food Canada, the Canadian Agri-Food Policy Institute, Pulse Canada, the Saskatchewan Pulse Growers, the Soy Foods Association of North America, the Nutrition Foundation of Italy (NFI), Nutra-Source Diagnostics, the McDougall Program, the Toronto Knowledge Translation Group (St. Michael's Hospital), the Canadian College of Naturopathic Medicine, The Hospital for Sick Children, the Canadian Nutrition Society (CNS), the American Society of Nutrition (ASN), Arizona State University, Paolo Sorbini Foundation and the Institute of Nutrition, Metabolism and Diabetes. He received an honorarium from the United States Department of Agriculture to present the 2013 W.O. Atwater Memorial Lecture. He received the 2013 Award for Excellence in Research from the International Nut and Dried Fruit Council. He received funding and travel support from the Canadian Society of Endocrinology and Metabolism to produce mini cases for the Canadian Diabetes Association (CDA). He is a member of the International Carbohydrate Quality Consortium (ICQC). His wife, ALJ, is a director and partner of Glycemic Index Laboratories, Inc., and his sister, CB, received funding through a grant from the St. Michael's Hospital Foundation to develop a cookbook for one of his studies. 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He has received travel support and/or honoraria from the American Peanut Council, American Pistachio Growers, Barilla, California Walnut Commission, Canola Council of Canada, General Mills, International Nut and Dried Fruit Council, International Pasta Organization, Loblaw Brands Ltd, Nutrition Foundation of Italy, Oldways Preservation Trust, Paramount Farms, Peanut Institute, Pulse Canada, Sabra Dipping Co., Saskatchewan Pulse Growers, Sun-Maid, Tate & Lyle, Unilever and White Wave Foods. He has served on the scientific advisory board for the International Tree Nut Council, International Pasta Organization, McCormick Science Institute, Oldways Preservation Trust, Paramount Farms and Pulse Canada. 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He has received travel support, speaker fees and/or honoraria from Diabetes Canada, Canadian Nutrition Society (CNS), Mott's LLP, Dairy Farmers of Canada, Sprim Brasil, WhiteWave Foods, Rippe Lifestyle, mdBriefcase, Alberta Milk, FoodMinds LLC, Memac Ogilvy & Mather LLC, PepsiCo, The Ginger Network LLC, International Sweeteners Association, Nestlé Nutrition Institute, Pulse Canada, Canadian Society for Endocrinology and Metabolism (CSEM), Barilla Centre for Food and Nutrition (BCFN) Foundation, and GI Foundation. He has or has had ad hoc consulting arrangements with Winston & Strawn LLP, Perkins Coie LLP, Tate & Lyle, and Wirtschaftliche Vereinigung Zucker e.V. He is a member of the European Fruit Juice Association Scientific Expert Panel. He is on the Clinical Practice Guidelines Expert Committees of Diabetes Canada, European Association for the study of Diabetes (EASD), Canadian Cardiovascular Society (CCS), and Canadian Obesity Network. He serves as an unpaid scientific advisor for the Food, Nutrition, and Safety Program (FNSP) and the Technical Committee on Carbohydrates of the International Life Science Institute (ILSI) North America. He is a member of the International Carbohydrate Quality Consortium (ICQC), Executive

Board Member of the Diabetes and Nutrition Study Group (DNSG) of the EASD, and Director of the Toronto 3D Knowledge Synthesis and Clinical Trials foundation. His wife is an employee of Unilever Canada.

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